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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
10/530,134	06/09/2005	Toru Hayashi	JFE-05-1040	9923

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EXAMINER

SHEVIN, MARK L

ART UNIT	PAPER NUMBER
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4116

MAIL DATE	DELIVERY MODE
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10/24/2007

PAPER

Please find below and/or attached an Office communication concerning this application or proceeding.

The time period for reply, if any, is set in the attached communication.

Office Action Summary

Application No.

10/530,134

Applicant(s)

HAYASHI ET AL.

Examiner

Mark L. Shevin

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-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) OR THIRTY (30) DAYS, WHICHEVER IS LONGER, FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

- 1) ☒ Responsive to communication(s) filed on 19 September 2007.
- 2a) ☐ This action is **FINAL**. 2b) ☒ This action is non-final.
- 3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

- 4) ☒ Claim(s) 1-16 is/are pending in the application.
- 4a) Of the above claim(s) 10-16 is/are withdrawn from consideration.
- 5) ☐ Claim(s) _____ is/are allowed.
- 6) ☒ Claim(s) 1-9 is/are rejected.
- 7) ☐ Claim(s) _____ is/are objected to.
- 8) ☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

- 9) ☐ The specification is objected to by the Examiner.
- 10) ☐ The drawing(s) filed on _____ is/are: a) ☐ accepted or b) ☐ objected to by the Examiner.
Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).
Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).
- 11) ☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

- 12) ☒ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
- a) ☒ All b) ☐ Some * c) ☐ None of:
- ☐ Certified copies of the priority documents have been received.
 - ☐ Certified copies of the priority documents have been received in Application No. _____.
 - ☒ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

- ☒ Notice of References Cited (PTO-892)
- ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
- ☒ Information Disclosure Statement(s) (PTO/SB/08)
Paper No(s)/Mail Date See Continuation Sheet.
- ☐ Interview Summary (PTO-413)
Paper No(s)/Mail Date. _____.
- ☐ Notice of Informal Patent Application
- ☐ Other: _____.

Continuation of Attachment(s) 3). Information Disclosure Statement(s) (PTO/SB/08), Paper No(s)/Mail Date :03/29/2007, 11/24/2006, 04/04/2005.

DETAILED ACTION

Status in view of Restriction:

1. Claims 1-16, filed 4 April 2005, are pending. The Examiner confirms that Applicant in his response on 19 September 2007 has elected invention 1, claims 1-9 for examination without traverse. Claims 10-16 are considered withdrawn.

Priority

2. Applicant is given the benefit under 35 USC 119 (a-d) to the priority date of 17 January 2003.

Information Disclosure Statement

3. The information disclosure statements submitted on 29 March 2007, 24 November 2006, and 4 April 2005 are in compliance with the provisions of 37 CFR 1.97. Accordingly, the information disclosure statements above are being considered by the Examiner. Please refer to applicants' copies of the 1449s submitted herewith.

Claim Rejections - 35 USC § 103

4. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negated by the manner in which the invention was made.

The factual inquiries set forth in *Graham v. John Deere Co.*, 383 U.S. 1, 148 USPQ 459 (1966), that are applied for establishing a background for determining obviousness under 35 U.S.C. 103(a) are summarized as follows:

1. Determining the scope and contents of the prior art.

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2. Ascertaining the differences between the prior art and the claims at issue.
3. Resolving the level of ordinary skill in the pertinent art.
4. Considering objective evidence present in the application indicating obviousness or nonobviousness.

5. **Claims 1-3, 7-8** are rejected under 35 U.S.C. 103(a) as being unpatentable over **Kurita** (US 6,083,455) in view of **Yoshida** (US 6,319,337).

Regarding claim 1, Kurita teaches a steel product having a high tensile and fatigue strength, excellent bending toughness with a ferrite-pearlite microstructure. Table 1 discloses a number of steel alloys of Kurita's invention that fall within the claimed composition range. For example, see steel Z5 (weight percent), with carbon: 0.39%, silicon: 0.05%, manganese: 0.42%. Kurita does not teach that the grain size must be 7 microns or less.

Yoshida teaches the if ferrite grains in a steel structure are too large, quenching crack sensitivity increases remarkably and therefore ferrite grain size number (JIS G0552, see Table A below) of the carbon steel should be 7 or higher (col 2, lines 60-64). *The Examiner interprets 'grain size' to mean average grain diameter.* Assuming roughly uniformly distributed and round grains, the 7 micron or less limitation of claim 1 works out to a JIS grain number of 10 or higher (the higher the grain number, the finer the grains). Thus the current limitation is within the range taught (and claimed in claim 2) by Yoshida as favorable in avoiding crack sensitivity.

TABLE A-continued

<u>JIS Grain Size Classification</u>		
Grain Size Number (N)	Number of Crystal Grains in Area of 1 mm ² (n)	Average Sectional Area of Crystal Grain (mm ²)
5	256	0.00390
6	512	0.00195
7	1024	0.00098
8	2048	0.00049
9	4096	0.000244
10	8192	0.000122

It would have been obvious to one of ordinary skill in the art at the time the invention was made to combine Kurita in view of Yoshida as Kurita teaches favorable compositions and microstructure for steels used in a power transmission role and Yoshida teaches how to refine the microstructure further by limiting the grain size. The particular limitation of 7 microns or less is, on its face, the result of the optimization of processing conditions in the course of routine experimentation. Material science and metallurgy in particular is focused in large part of the effect of grain size.

Regarding claim 2, Kurita teaches that molybdenum, if added, has an effect of improving toughness but that molybdenum is saturated at 0.30% (col 6, lines 46-52). Kurita also demonstrates a few steel compositions in the claimed C, Si, Mn, and Mo range in Table 3, see Steels 4 and 9 for example.

Yoshida also teaches that adding 0.4 or lower weight percent of Mo improves hardenability and that above 0.4%, the effect of hardenability reaches a plateau (col 3, lines 24-27).

Regarding claim 3, Kurita teaches a steel that meets the composition limitations of claims 1 and 2 and further includes aluminum in the claimed range, see Steels 11 and 14 in Table 3.

Regarding claim 7, Kurita teaches nitriding is carried out through "gas nitriding" where hot gas is passed by the steel product for many hours to diffuse nitrogen into the surface (col 9, lines 23-36) and the ferrite grain size could be controlled by the optimization of process conditions in the course of routine experimentation. This size could be adjusted by using a precursor steel with a smaller outer ferrite grain size before nitriding.

Regarding claim 8, Kurita teaches a steel that meets the composition limitations of claims 1 and 2 and further includes aluminum in the claimed range, see Steels 11 and 14 in Table 3.

6. **Claims 4 and 9** are rejected under 35 U.S.C. 103(a) as being unpatentable over **Kurita** (US 6,083,455) in view of **Yoshida** (US 6,319,337) as applied to claims 1-3 above, and further in view of **Yoshida** (US 6,390,924).

What Kurita and Yoshida '337 teach was discussed in the 103 rejection to claim 1 above, however neither reference explicitly teaches how much of the cementite phase one should have in a favorable high-strength, high fatigue strength steel.

Regarding claims 4 and 9, Yoshida '924 discusses steel compositions for power transmission shafts where cementite content in the steel is converted to graphite through graphitization annealing allowing the product to have more residual

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compressive stress on the surface, resulting in greater strength and fatigue resistance (col 3, lines 1-19).

It would have been obvious to one of ordinary skill in the art to combine Yoshida '924 with the previously established combination of Kurita in view of Yoshida '337 to include more than 4 volume percent cementite as Yoshida '924 implies that this cementite can be transformed into graphite and then martensite to yield a product with higher strength and higher resistance to fatigue. The particular limitation of 4 volume percent is on its face the result of the optimization of ranges in the course of routine experimentation as one would vary the amount of cementite phase present in a steel product depending on the properties required on the final, finished product.

7. **Claims 5 and 6** are rejected under 35 U.S.C. 103(a) as being unpatentable over **Kurita** (US 6,083,455) in view of **Yoshida** (US 6,319,337) as applied to claims 1-3 above, and further in view of **Ochi** (US 5,545,267)

What Kurita and Yoshida '337 teach was discussed in the 103 rejection to claim 1 above, however neither reference explicitly teaches what the grain size of the prior austenite grains should be after induction quenching.

Regarding claim 5, Ochi teaches how one would more preferably go about hardening a steel shaft for excellent torsional strength by induction heating the steel such that the grain size number of the prior austenite grains is 9 or more, which under the same assumptions of claim 1 regarding grain geometry, corresponds to grain sizes of approximately 8.8 microns or less, which is within the claimed range. (col 8, lines 34-42). Ochi teaches that if the prior austenite grains are any larger (smaller grain size

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number) then the effect of preventing the brittle fracture caused by intergranular fracture is small (col 8, lines 40-45).

It would have been obvious to one of ordinary skill in the art at the time the invention was made to combine Ochi with the combination of Kurita in view of Yoshida '337 established in the 103 rejection to claim 1 above to produce a steel product with a martensite surface layer having prior austenite grain sizes less than 12 microns as Ochi taught the advantages of limiting the prior-austenite grains in terms of preventing brittle fracture. Furthermore induction hardening is well known to produce martensite and harden the surface of steel as evidenced by the ASM Handbook (Volume 1: Properties and Selection, Irons, Steels, and High Performance Alloys, *Fatigue Resistance of Steels* edited by B. Boardman, copyright 1997).

Regarding claim 6, Kurita teaches a steel that meets the composition limitations of claims 1 and 2 and further includes aluminum in the claimed range, see Steels 11 and 14 in Table 3.

Additional Relevant Prior Art:

8. The prior art made of record and not relied upon is considered pertinent to applicant's disclosure.

Ochi: 6,383,311

Induction hardening of a drive shaft

6,660,105

Steel compositions for gear-wheels, bearing parts, rolling parts, shafts, and constant velocity joints that are later carburized

6,602,358:

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Steel compositions for the outer section of a constant-velocity joint with ferritic microstructure. Also see col 6, lines 20-35 for more about prior austenitic grain sizes.

Toyooka: 6,331,216:

See col 3, lines 5-20 about grain sizes

6,290,789

Table 16, steels E and H

Kanisawa 6,551,419

Hot rolled steel bar with ferrite and pearlite microstructure

Conclusion

1. Claims 1-9 are rejected.
2. No claims are allowed.

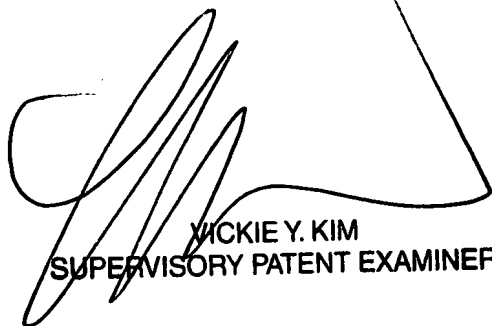
Any inquiry concerning this communication or earlier communications from the examiner should be directed to Mark L. Shevin whose telephone number is (571) 270-3588. The examiner can normally be reached on Monday - Thursday, 8:30 AM - 5:00 PM EST.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Vickie Kim can be reached on (571) 272-0579. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

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Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see <http://pair-direct.uspto.gov>. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free). If you would like assistance from a USPTO Customer Service Representative or access to the automated information system, call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.

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10-530,134



VICKIE Y. KIM
SUPERVISORY PATENT EXAMINER